

A trial of slash and burn management of Coast Tea-tree *Leptospermum laevigatum* on Wonthaggi Heathland

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Abstract

In 2000, a trial program of management of the Wonthaggi Heathland Nature Conservation Reserve was implemented. This used the slash and burn technique in small patches of vegetation. The aims were: to assess the invasion of Coast Tea-tree *Leptospermum laevigatum*, to determine the effect of each treatment on species richness and to observe the response of weeds and orchids. Post-treatment monitoring was carried out in 2008, 2009 and 2012. The results from this trial show that these management strategies reduce the invasion of Sand and Wet Heathland EVCs by Coast Tea-tree and enhance species diversity. It would be appropriate to extend the area of management and continue to monitor the results over the long term. (*The Victorian Naturalist* 130 (5) 2013, 212–218).

Key Words Coast Tea-tree, slash and burn management, Sand and Wet Heathland

Introduction

Wonthaggi Heathland Nature Conservation Reserve (WHNCR) covers 811 ha extending from the outskirts of Wonthaggi south to the coast and east to Harmers Haven. The vegetation has been mapped as Sand and Wet Heathland (EVCs 6 and 8) and Coast Banksia Woodland (EVC 2), with Coast Dune Scrub Mosaic (EVC 1) along the dunes (Davies *et al.* 2002). In 1985 large sections of the reserve were burnt. Since then there have been controlled burns over small areas in different parts of the reserve in 2000, 2007, 2008, 2009 and 2010. These burns were part of the fire prevention management plan to reduce the fuel load in a reserve close to the town and as ecological burns to enhance biodiversity.

Over the last couple of decades the invasion of Coast Tea-tree *Leptospermum laevigatum* into heathland vegetation has become a significant concern for the Friends of Wonthaggi Heathland, volunteers who care for the heathland and work closely with Parks Victoria. Their concern is that Coast Tea-tree does not belong in Sand and Wet Heathland (Davies *et al.* 2002) and that its invasion may reduce the biodiversity of these EVCs.

In addition, this reserve is one of the sites used in the study of the rare and threatened Eastern Spider Orchid *Caladenia orientalis* by the Department of Sustainability and Environment (DSE) (now Department of Environment and

Primary Industries). It is important that management should not have an adverse impact on this species.

Coast Tea-tree develops as a small, single-stemmed tree reaching a height of 8–12 m, with a life span of 100–150 years. Although the trees are killed by fire, seeds are not, as they are protected by the hard woody capsules. These capsules drop from the plant and remain closed, but open soon after a fire. Germination is prolific in the following winter (Burrell 1981). As many as 400 seedlings per square metre (M Ellis pers. obs.) germinated post-fire at Wilsons Promontory National Park (WPNP) in 2006. Seed is usually viable for one year. Most seeds germinate in the first year after a fire.

Invasion of Coast Tea-tree into heathland shows a variety of effects caused by fire. Burrell (1981) showed that three factors were necessary to produce extensive areas of Coast Tea-tree: disturbed topsoil, a temporary increase in soil phosphorus level and release of the accumulated reservoir of seed. Fire was suggested as the factor likely to produce these conditions; however, Bennett (1994) considered that fire was not a pre-requisite for Coast Tea-tree expansion on the Yanakie Isthmus at WPNP, but that grazing pressure may have been the cause, due to the exposure of bare ground and the restriction of the feeding range of cattle. Fire suppression was a possible cause of invasion of

Coast Tea-tree into remnants of Heath Tea-tree *Leptospermum myrsinoides* heathland in suburban areas of Melbourne (Browning 2004). It is, therefore, appropriate to test the effect of fire *in situ* in order to develop a management strategy for the WHNCR.

Methods

In 2000, a trial program of management of the reserve was implemented using slash and burn in small areas of vegetation, with the aims: to assess the invasion of Coast Tea-tree, to determine the effect of each treatment on species richness and to observe the response of individual species of weeds and orchids where appropriate. Plant species were named according to Walsh and Stajic (2007).

An area of approximately 6 ha was selected for the trial (Fig. 1). Within this area, four permanent 20 × 20 m quadrats (A, B, C and E on map) were established. A control quadrat (D) was set up in the long-unburnt area. It may be 30 to 40

years since this was last burnt. The treatments for each quadrat were as follows: A. Dry Tea-tree was burnt in 2002, slashed in mid 2007, burnt in 2010; B. Dry Tea-tree was burnt in 2000, slashed in mid 2007 and burnt in 2008; C. Dry, light cover of Tea-tree was burnt in 2000 and 2008; and E. Moist Tea-tree, burnt in 2000 and 2008.

Vegetation monitoring was carried out in October 2008, September 2009 and October-November 2012. Quadrats (1 × 1 m) in the centre and in each corner of the 20 × 20 m quadrats were examined, recording all species present and all Coast Tea-tree seedlings. We also recorded any additional species present in the 20 × 20 m quadrat. Exact counts of species and seedlings were possible in all the treatments. In the control D, only a rough calculation of the total number of mature Coast Tea-trees could be made, by multiplying the mean number in 1 × 1 m by 400 as the quadrat was virtually im-

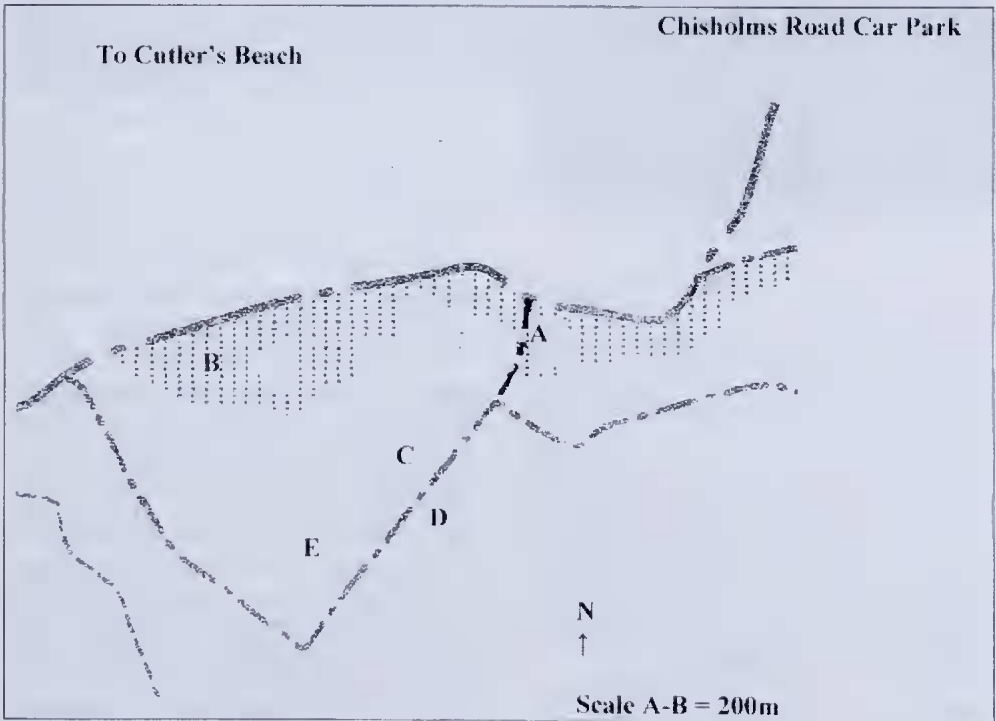


Fig. 1. Location of quadrats in trial area. Shaded area was slashed in 2007.



Fig. 2. Redbeaks *Pyrorchis nigricans*.

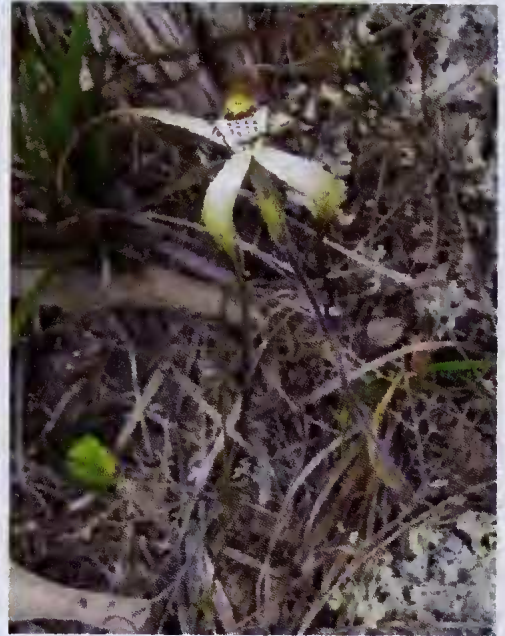


Fig. 3. Eastern Spider Orchid *Caladenia orientalis*.

penetrable, with access on hands and knees to each 1×1 m quadrat.

We have presented the results as tables of means per five 1×1 m quadrats and the total number of species in 20×20 m quadrats for the three field days.

In October 2008, following fire the previous autumn, there were numerous Redbeaks *Pyrorchis nigricans* (Fig. 2) flowering on the heathland. Using four of our 1×1 m quadrats we counted the total number of Redbeaks per square metre and the number flowering. We also counted Eastern Spider Orchids *Caladenia orientalis* (Fig. 3) in the same area.

Results

Invasion of Coast Tea-tree

There is almost no recruitment of Coast Tea-tree under mature closed-canopy tea-tree

heath. This is borne out in the data for the control D (Table 1). In treatment A, there was considerable recruitment in the first two years after slashing, but it was reduced to the control level within two years of the 2010 burn. The lowest recruitment occurred in treatment B with two burns and slashing one year before the second burn. In treatments C and E there were similar results except for one anomaly in treatment C, 69 seedlings in the north east corner, possibly from one parent plant, after the burn in 2008.

The effect of each treatment on species richness

The only quadrat with mature Coast Tea-tree is the control (D) where the lowest number of understorey species was found (Table 2).

In the first year after the fire, species diversity as determined by counting the number of species present in 20×20 m quadrats was very similar in all treatments as well as the control (Table 3). By the second year there were greater numbers. The numbers all dropped by the fourth year after the last fire.

The regrowth of vegetation after the fire produced a dense heath in all treatments with less than 20% bare ground and a height of less than 1 m in the first year and up to 1.25 m by the



Fig. 4. The dense heath in quadrat B, November 2012.

fourth year (Fig. 4). In the control quadrat, the mature Coast Tea-tree reached 4 m in height, bare ground was 20% and litter 70%. There was no litter in the treatment areas.

Response of weeds

There are very few weeds on the heathland and only two species were recorded in the quadrats. Dandelion *Taraxacum officinale* occurred in three 1 × 1 m quadrats in 2008 and Cat's-ear *Hypochoeris radicata* was found in seven 1 × 1 m quadrats in 2009 and in one quadrat in 2012. In every instance the percentage cover was just a trace.

Response of orchids

In October 2008, there were numerous Red-beaks leaves per square metre, a quarter of them with flowers. Of Eastern Spider Orchids in the same area, half of them were in flower (Table 4).

In the trial quadrats the number of orchid species found was very low compared with the

total number of orchid species known to occur in the Reserve (Table 5). Over a lifetime of visiting the Reserve, 74 species have been recorded (T Allen pers. obs.).

Discussion

The primary value of the trial is that detailed observations were made so that we have a measure of the effect of the treatments on the invasion of Coast Tea-tree, on species richness, on weeds and on two orchid species, one of which is a known fire response species and one which is rare. This was a small trial in a restricted area, but accumulation of results from similar work elsewhere can elucidate appropriate management strategies and are worth reporting.

Mature Coast Tea-tree does not burn easily because there is so little fuel underneath the canopy; slashing prepares a fuel load that will burn readily. Given that Coast Tea-tree capsules don't open until dropped, that seeds are only viable for one year and that it is a fire responsive species, slashing a year prior to burn-

Table 1. Mean Number of seedling Coast Tea-tree in five 1 × 1 m quadrats.

Quadrat	EVC	Treatment	Date	Mean
A	Sand Heathland	Burnt 2002, slashed 2007, burnt 2010	6/10/08	14.8
			24/9/09	30
			25/10/12	2.6
B	Sand Heathland	Burnt 2000, slashed 2007, burnt 2008	6/10/08	2.4
			24/9/09	1.4
			19/11/12	1
C	Sand Heathland	Burnt 2000, 2008	6/10/08	13.8
			24/9/09	0.6
			25/10/12	5.2
D	Sand Heathland	Control unburnt 30-40 years	6/10/08	0
			24/9/09	0
			25/10/12	2.6
E	Wet Heathland	Burnt 2000, 2008	6/10/08	6.4
			24/9/09	5.4
			25/10/12	0.2

Table 2. Mean number of understorey (U) and total number of canopy (C) species in five 1 × 1 m quadrats.

Quadrat	EVC	Treatment	Date	Mean U	Mean C
A	Sand Heathland	Burnt 2002, slashed 2007, burnt 2010	6/10/08	13.2	0
			24/9/09	13	0
			25/10/12	19.6	0
B	Sand Heathland	Burnt 2000, slashed 2007, burnt 2008	6/10/08	10.4	0
			24/9/09	15.4	0
			19/11/12	8.6	0
C	Sand Heathland	Burnt 2000, 2008	6/10/08	12.2	0
			24/9/09	17.8	0
			25/10/12	15.6	0
D	Sand Heathland	Control unburnt 30-40 years	6/10/08	7	8
			24/9/09	6	5
			25/10/12	6.4	6
E	Wet Heathland	Burnt 2000, 2008	6/10/08	18.2	0
			24/9/09	21.6	0
			25/10/12	10.2	0

Table 3. Total number of species in 20 × 20 m quadrats on each field day.

Quadrat	EVC	Treatment	2008	2009	2012
A	Sand Heathland	Burnt 2002, slashed 2007, burnt 2010	36	44	55
B	Sand Heathland	Burnt 2000, slashed 2007, burnt 2008	31	60	41
C	Sand Heathland	Burnt 2000, 2008	38	59	40
D	Sand Heathland	Control unburnt 30-40 years	33	35	22
E	Wet Heathland	Burnt 2000, 2008	31	40	32

Table 4. Mean number of orchids present and percentage (%) flowering.

Orchid spp.	Scientific name	Total	Flowering	% flowering
Redbeaks	<i>Pyrorchis nigricans</i>	186	47	25
Eastern Spider Orchids	<i>Caladenia orientalis</i>	50	25	50

Table 5. Number of orchid species found in 1 × 1 m quadrats.

Quadrat	EVC	Treatment	2008	2009	2012
A	Sand Heathland	Burnt 2002, slashed 2007, burnt 2010	0	1	3
B	Sand Heathland	Burnt 2000, slashed 2007, burnt 2008	1	4	0
C	Sand Heathland	Burnt 2000, 2008	4	5	3
D	Sand Heathland	Control unburnt 30-40 years	0	0	0
E	Wet Heathland	Burnt 2000, 2008	1	0	1

ing may remove viable seeds, so that the burn does not stimulate germination. At WPNP, after the 2005 fire, the mean number of stems of Coast Tea-tree in 1 × 1 m quadrats was more than 200 in the first year, decreasing slightly in the second year and down to 150 by the fourth year post fire (Tolsma and Cheal 2012). This is 10 times the number of stems recorded in the Wonthaggi trial. They also noted a very low level of recruitment of Coast Tea-tree in unburnt sites at WPNP.

After germination it takes only four years before Coast Tea-tree plants flower and set seed (M Ellis pers. obs.). The interval between burns in this trial was eight years, whereas the interval between slashing and burning was three years in treatment A and 1 year in treatment B. There were more seedlings recorded in treatment A in the two years after slashing than in any of the other treatments. In the last assessment in 2012, numbers of seedlings were back to the same level as in the control. Heathland reaches maturity at 8 years and wanes after 33 years; the recommended fire interval for management is 12 to 45 years (Cheal 2010). It is reasonable to conclude that the slash and burn technique does reduce the invasion of Coast Tea-tree, but the information that is missing from this trial is the effect of slashing alone.

After a burn there is a demonstrable increase in species richness in all treatments in the first two years. By the fourth year species richness, although reduced, remains greater than in the control. This may be attributed to the retreat of short-lived ephemerals to a soil seed store, as suggested by Tolsma and Cheal (2012) for the post-fire monitoring at WPNP.

Weeds do not penetrate dense heath and even the bare ground immediately following the fire was not invaded by pest plants. This compares with searches at WPNP after the 2009 fire, which found few weeds, suggesting that vegeta-

tion communities on sandy soils are not prone to post-fire weed invasion (Tolsma *et al.* 2011). Slashing and fire had no detrimental effect on the orchid species. Redbeaks seldom flowers without fire, but large numbers appear in a colony following fires (Foster and MacDonald 1999). The Eastern Spider Orchid population on WHNCR is monitored regularly as part of the study by DSE and does not appear to be detrimentally affected by the slash and burn management.

Conclusion

The results from this trial show that these management strategies reduce the invasion by Coast Tea-tree of Sand and Wet Heathland EVCs and enhance species diversity. Weeds were insignificant and would not be a management problem. The slash and burn technique had no detrimental effect on the two orchid species. It would be appropriate to extend the area of management and continue to monitor the results over the long term. We would recommend that the interval between burns be extended to at least 12 years and that an area be set aside for slashing only to determine the effect on Coast Tea-tree recruitment.

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Curious minds: the discoveries of Australian naturalists

by Peter Macinnes

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Curious minds: the discoveries of Australian naturalists is the most recent in a line of beautifully presented books from the National Library of Australia (NLA) on historical aspects of Australian natural history. The objective is to publish books as part of the process of interpreting and highlighting the NLA collection. This much is part of the charter of the Library, and this book is a fine example of the production standard that has been achieved in fulfilling that role.

The text consists of 26 short biographical essays. The subjects of these pieces are individuals, 39 in number, who are judged to have made contributions to an understanding of Australian natural history, in a 200-year-period beginning in the 1680s. These biographical sketches are grouped in six sections, under headings that are meant to indicate something of the circumstances or type of activity in which the contribution was made. These sections are presented in more-or-less chronological order, following a brief Introduction.

In the first section, 'Australian nature discovered', the focus of attention in four essays is on William Dampier, Willem de Vlamingh, Jacques La Billardière, Claude Riche, Charles-Alexandre Lesueur and Francois Péron. 'Putting Australian nature on the map' (four essays) looks at the

roles of Joseph Banks, Sydney Parkinson, James Cook, Charles Darwin, Ferdinand Bauer, Robert Brown, Matthew Flinders, Amelie Dietrich and Georgiana Molloy. Three essays under the heading 'Australia expanded' focus on George Bennett, John White, Thomas Watling, Thomas Huxley, and John Macgillivray. The five essays comprising 'Makers of their own fates' draws attention to Allan Cunningham, Richard Cunningham, Ludwig Leichhardt, John Gilbert, Thomas Mitchell, William Blandowski, and Gerard Krefft. Under the heading of 'True-blue naturalists', the author has included Ferdinand Mueller, Louisa Meredith, Harriet and Helena Scott, Louisa Atkinson, Ellis Rowan and William Macleay. The final section is titled 'Australia live' and looks at John Lewin, John and Elizabeth Gould, George Angus and William Caldwell.

The book concludes with a few paragraphs on 'The value of a curious mind'. Although short, it expresses a number of disparate thoughts; after a couple of readings of the piece, it is still unclear to this reviewer what value is being promoted.

Given the large number of 'curious minds' who might have been included in this book, it is reasonable to assume that those individuals who are featured have been chosen especially by